Comprehensive assessment of the carcinogenic risk to adolescent health of chemicals

Evaluación integral del riesgo carcinogénico de las sustancias químicas para la salud de los adolescentes.

Valeeva Emiliya Ramzievna[1], Ismagilova G.A.[2], http://www.scopus.com/authid/detail.url?authorId=57034032300, Stepanova N.V[3], Ziyatdinova A.I[4], IDScopus15048984100
[1]Doctor of Medical Sciences, Professor, Department of Bioecology, Hygiene and Public Health, Institute of Fundamental Medicine and Biology, Kazan Federal University, Tel. +79030613856; Email: val_med@mail.ru, ID Scopus 6506857648
[2]graduate student Department of Bioecology, Hygiene and Public Health, Institute of Fundamental Medicine and Biology, Kazan Federal University; Email: gulgena_76@mail.ru,
[3]Doctor of Medical Sciences, Professor, Department of Bioecology, Hygiene and Public Health, Institute of Fundamental Medicine and Biology, Kazan Federal University; Email: stepmed@mail.ru, ID Scopus 56712449900
[4]Doctor of Biological Sciences, docent, Department of Human Health, Institute of Fundamental Medicine and Biology, Kazan Federal University; Email: alfiya.ishakovna@mail.ru,
Received/Recibido: 08/28/2020 Accepted/Aceptado: 09/15/2020 Published/Publicado: 11/09/2020 DOI: 10.5281/zenodo.4425066

Abstract

The value of total carcinogenic risk on peroral, inhalation and dermal routes of entry for the adolescent population in all zones under study corresponded to high risk level, the highest values being observed in the 1st zone (the Kirovsky district), and the lowest ones in the 4th zone (the Privolzhsky district). The priority routes of carcinogen entry into the human body were peroral and inhalation routes. Foods and drinking water, as well as atmospheric air were revealed to be the leading substance transport media in forming individual carcinogenic risk. The major carcinogens forming risk were lead (1.36E-04), chloroform (1.20E-04) and cadmium (7.09E-04) entering with water and arsenic (8.38E-05) – with soil. The leading position among atmospheric air carcinogens in all city zones under study belonged to soot (5.51E-04). The priority pollutant present in foods and defining carcinogenic health risk was lead (2.02E-03). Complex assessment of carcinogenic risk in case of multimedium routes of the chemicals' entry showed that there was a risk of developing carcinogenic effects for the adolescents' health on daily intake of contaminants, which made THCR=0.01632.

Key words: comprehensive assessment of carcinogenic risk in adolescents.

Resumen

El valor del riesgo carcinogénico total por vías de entrada peroral, inhalatoria y dérmica para la población adolescente en todas las zonas de estudio correspondió al nivel de riesgo alto, observándose los valores más altos en la 1a zona (distrito de Kirovsky) y los más bajos en la cuarta zona (el distrito Privolzhsky). Las rutas prioritarias de entrada de carcinógenos en el cuerpo humano fueron las vías perorales y de inhalación. Se reveló que los alimentos y el agua potable, así como el aire atmosférico, son los principales medios de transporte de sustancias en la formación de riesgo cancerígeno individual. Los principales carcinógenos de riesgo de formación fueron el plomo (1.36Å-04), el cloroformo (1.20Å-04) y el cadmio (7.09E-04) que ingresaron con agua y arsénico (8.38Å-05) - con el suelo. La posición de liderazgo entre los carcinógenos atmosféricos del aire en todas las zonas de la ciudad en estudio fue el hollín (5.51E-04). El contaminante prioritario presente en los alimentos y que define el riesgo cancerígeno para la salud fue el plomo (2.02E-03). La evaluación compleja del riesgo carcinogénico en el caso de rutas de entrada de sustancias químicas con múltiples medios mostró que existía el riesgo de desarrollar efectos carcinogénicos para la salud de los adolescentes en la ingesta diaria de contaminantes, lo que hizo que THCR = 0,01632.

Palabras clave: Evaluación integral del riesgo carcinogénico en adolescentes.

Introduction

The growing anthropogenic impact on nature and human being, as well as the growth of the population incidence rate necessitate a complex assessment of the human habitat factors based on calculation of risks and damages to the population health[1-6]. The urgent character of this topic lies in the fact that ecological assessment of the living standards parameters

under present-day conditions of the anthropogenic activity growth becomes more and more required, and is projected onto a wide range of the living environment components[7-12].

The aim of the study was to assess the risk of developing carcinogenic effects for the adolescent health on multimedium routes of the chemicals' entry from the environmental compartments of the city.

Methods

The data obtained from calculation of individual risk from the content of carcinogens in all media of the zones under study in the city of Kazan allowed to identify the total carcinogenic risk for each route of entry and the total carcinogenic risk for all routes in adolescents. On complex exposure of adolescents to chemicals in all zones under study in the city of Kazan, we identified the major routes of their entry; they were the paroral route – 85.87% and the inhalation one - 12.07%. Therewith, a decrease of the contaminants' entry from the 1st zone to the 4th zone was observed. The contribution of dermal route to the total carcinogenic risk was insignificant and made 2.05%. The risk of developing carcinogenic effects was assessed according to "Guidelines for the population health risk assessment on exposure to chemicals contaminating the environment "P.2.1.10.1920-04[13].

To calculate exposure, a median of 50 % and 95% Perc of the chemicals' content in the environmental compartments were used. The factor of carcinogenic potential on inhalation (SFI), peroral (SFO) and dermal (SFD) routes of exposure was identified for chemical carcinogens for subsequent risk assessment. The indices were calculated for 4 zones of the city of Kazan: the 1st zone – the Kirovsky district, the 2nd zone – the Vakhitovsky district, the 3rd zone – the Sovetsky district, and the 4th zone – the Privolzhsky district.

The value of individual carcinogenic risk (CR) for each chemical component was calculated as a product of chronic daily intake and carcinogenicity index according to formula (1):

$$CR = I \cdot SF, \quad (1)$$

where I – a value of substance intake throughout life; SF - carcinogenicity index (a slope factor).

Combined impact of carcinogenic factors on one route of entry was treated as additive and was calculated according to formula (2):

$$CR_T = \Sigma CR_i, \quad (2)$$

where CR_T – the total carcinogenic risk; CR_i - carcinogenic risks caused by the chemical mixture components.

In case of simultaneous exposure to several carcinogenic substances entering the human body via different routes, calculation of the total risk (TCR) is made according to formula (3):

$$TCR = \Sigma CR_i, \quad (3)$$

where TCR - the total carcinogenic risk.

Statistical analysis of the obtained data was performed in operating system Windows 10, with use of standard application program Excel 2010.

Results

The carried out calculations of individual carcinogenic risk due to inhalation route chemicals' entry (atmospheric air, water, soil) in the zones under study according to 50% Perc showed that its minimum values were at the level of 2.56E-04 (the 4th zone – the Privolzhsky district), and the maximum ones were 7.05E-04 (the 1st zone – the Kirovsky district) (Table 1).

Table 1. Comprehensive assessment of the carcinogenic risk of adolescents with multi-media exposure to chemicals (50% Perc)

	Zones									
Way and environment of receipt	1 zona	2 zona	3 zona	4 zona	Amount	1 zona %	2 zona %	3 zona %	4 zona %	Amount %
Inhalation route										
Atmospheric air	0,0006	0,0004	0,0003	0,0002	0,001	30,69	23,25	18,78	11,83	84,57
Water	9,20758E-05	8,63521E-05	7,69142E-05	1,65130 E-05	0,0002	4,671	4,38	3,90	0,83	13,79
The soil	7,90679E-06	8,33854E-06	9,32898E-06	6,54324E-06	3,212E-05	0,401	0,423	0,47	0,33	1,62
Peroral exposure										
Products	0,0027	0,0027	0,0027	0,0027	0,0109	19,615	19,615	19,61	19,61	78,46
Water	0,0009	0,0008	0,0007	0,0001	0,0027	6,568	6,16	5,48	1,17	19,39
The soil	0,00007	0,00007	0,00008	0,00006	0,00030	0,520	0,54	0,64	0,445	2,14
Cutaneous path										
Water	1,195E-05	1,035E-05	1,026E-05	1,866E-06	3,447E-05	27,77	26,38	25	20,83	99,17
The soil	8,999E-05	7,586E-05	7,292E-05	6,181E-05	0,000301	32,3	22,13	32,28	13,32	0,83
HCRi	0,0007	0,0005	0,0004	0,0002	0,001	4,319	3,388	2,797	1,569	12,07
HCRo	0,0037	0,0036	0,0036	0,0029	0,014	22,93	22,59	22,10	18,23	85,87
HCRd	0,0001	0,00008	0,00008	0,00006	0,0003	0,624	0,528	0,509	0,390	2,052
THCR	0,0045	0,0043	0,0041	0,0032	0,0163	27,87	26,51	25,41	20,19	100

The contribution of the media under study on the inhalation entry of chemicals was distributed in the following way: the atmospheric air ranked first (84.58%), water ranked second (13.79%), and soil ranked third (1.63%). Consequently, the major contribution to the inhalation entry of chemicals was made by the atmospheric air (84.58%). Water occupied the next position mainly due to intake of lead and chloroform in all zones, in the 2nd zone (the Vakhitovsky district) (1.36E-05 and 1.20E-05 correspondingly), and cadmium in the 1st zone (7.09E-05) in particular. The lowest contribution was made by soil (1.63%), mainly as a result of arsenic intake in all zones, in the 2nd and the 3rd (the Sovetsky district) zones (6.44E-06 and 8.38E-06 correspondingly) in particular.

Carcinogenic risk from exposure to the atmospheric air in the zones under study was distributed in such a way that its minimum values were at the level of 2.33E-04 (the 4th zone), the maximum ones were 6.05E-04 (the 1st zone). Carbon (soot) in all zones and benzo(a)pyrene in the 4th zone (2.12E-05) ranked high in its formation. The adolescents living in the 1st zone (the Kirovsky district) of the city, where the individual risk of developing cancer was the highest (7.05E-04), were exposed to the highest risk from the total inhalation effect of substances.

The total carcinogenic risk with the account of peroral exposure (foods, drinking water and soil) ranged from 2.98E-03 (the 4th zone) to 3.74E-03 (the 1st zone). The contribution of the media under study to the peroral route of the chemicals' entry was distributed in the following way: foods ranked first (78.46%), the drinking water ranked second (19.39%), and soil ranked third (2.14%). Thus, it can be said that the major contribution to peroral route of the chemicals' entry is made by foods (78.46%), and the lowest one – by soil (2.14%), mainly as a result of arsenic intake in all zones, in the 2nd and the 3rd zones (6.44E-05 and 8.38E-05 correspondingly) in particular.

Carcinogenic risk from exposure to drinking water in the zones under study was distributed in such a way that its minimum values were at the level of 1.65E-04, and the maximum ones – 9.21E-04. The leading role in its formation in all zones is caused by the intake of lead and chloroform, (1.36E-04 and 1.20E-04 correspondingly) and that of cadmium in the 1st zone (7.09E-04) in particular. The percentage of carcinogenic risk on intake with foods (78.6%) was identified mainly as a result of lead contamination in adolescents (2.02E-03). The highest total carcinogenic risk from the chemicals' entry via the peroral route was registered in the 1st (3.74E-03) and the 2nd (3.69E-03) zones of the city, where the individual risk of developing cancer was the highest.

We determined that on dermal exposure (water and soil) the minimum values of the total carcinogenic risk were at the level of 6.37E-05 (the 4th zone), and the maximum ones – 1.02E-04 (the 1st zone). The contribution to the dermal route of the chemicals' entry was distributed in such a way that the major contribution was made by soil (89.7%), and the lowest one - by water (10.3%), mainly as result of lead and chloroform intake in all zones, in the 2nd zone (1.22E-06 and 1.57E-06 correspondingly), and that of cadmium in the 1st zone (1.18E-05) in particular.

Carcinogenic risk from exposure to soil in the zones under study varied from 6.18E-05 (the 4th zone) to 8.99E-05 (the 1st zone); the leading role in its formation was caused by arsenic intake, in the 1st and the 2nd zones (8.38E-05 and 6.44E-05 correspondingly) in particular. The highest total carcinogenic risk from the chemicals' entry via dermal route was observed in the 1st city zone (1.02E-04), where the individual risk of developing cancer was the highest.

Analysis of total carcinogenic risks due to simultaneous entry of chemicals from all media of exposure and via all major routes showed that the adolescents living in the 1st zone were exposed to the highest lifelong individual risk; the 2nd and the 3rd city zones had practically equal values; and a minimum risk was observed on the territory of the 4th zone.

Comparative assessment of individual carcinogenic risk in adolescents on particular areas of the city allows revealing the contribution of certain zones to the total risk value for the entire analyzed territory of the city of Kazan. The total carcinogenic risk for all routes of the chemicals' entry into the adolescent bodies in all four zones made 0.01632 corresponding to the high risk level (10^{-1} - 10^{-3}), where the contribution fell on the peroral route and made the values from 0.00298 – 0.00374.

Thus, the major contribution to the total carcinogenic individual risk on the territory under study is made by the 1st zone – 27.9%; the 2nd zone – 26.5% and the 3rd zone – 25.4% have practically equal values; and the lowest contribution is made by the 4th zone – 20.2%.

The obtained results allowed to reveal the highest and the lowest contributions of the exposure media and routes of the chemicals' entry, identify the priority contaminants and the routes of their entry into the adolescent bodies, identify the zones, where the adolescents were most often exposed to carcinogenic risk, and also determine the total carcinogenic risk for each route of carcinogen entry and the total carcinogenic risk for all routes in adolescents in all four zones, which made 0.02681 corresponding to the high risk level (10^{-1} - 10^{3}) (Table 2).

Table 2. Comprehensive assessment of carcinogenic risk in adolescents with multi-environmental exposure to chemicals (95% Perc)										
	Zones									
Way and environment of receipt	1 zona	2 zona	3 zona	4 zona	Amount	1 zona %	2 zona %	3 zona %	4 zona %	Amount %
Inhalation route										
Atmospheric air	0,0016	0,00117	0,0010	0,00042	0,0042	34,91	25,24	22,61	9,200	91,98
Water	0,00011	0,00010	0,000087	0,000018	0,00032	2,39	2,27	1,87	0,40	6,95
The soil	1,25046E-05	1,29138E-05	1,26953E-05	1,11347E-05	4,925E-05	0,2687	0,2775	0,27	0,23	1,05
Peroral exposure										
Products	0,0044	0,00448	0,0044	0,00448	0,017	20,73	20,73	20,73	20,73	82,92
Water	0,0011	0,00105	0,0008	0,00018	0,003	5,15	4,89	4,03	0,86	14,95
The soil	0,00011	0,00011	0,00012	0,00010	0,00046	0,54	0,53	0,57	0,48	2,12
Cutaneous path										
Water	1,34441E-05	1,18177E-05	1,16426E-05	2,12847E-06	3,903E-05	2,69E+00	2,37E+00	2,33E+00	4,26E-01	7,82E+00
The soil	0,00012	0,00011	0,00011	0,00010	0,0004	2,48E+01	2,33E+01	2,32E+01	2,08E+01	9,22E+01
HCRi	0,0017	0,0012	0,0011	0,00045	0,004	6,52	4,82	4,29	1,70	17,35
HCRo	0,0057	0,0056	0,0054	0,00478	0,0216	21,34	21,13	20,46	17,83	80,77
HCRd	0,00013	0,00012	0,00012	0,00010	0,0004	0,51	0,47	0,47	0,39	1,86
THCR	0,0076	0,00708	0,0067	0,0053	0,0268	28,37	26,43	25,24	19,94	100

The performed calculations of individual carcinogenic risk caused by the inhalation route of the chemicals' entry (the atmospheric air, water, soil) in the zones under study according to 95% Perc showed that its minimum values were at the level of 4.58E-04 (the 4th zone), and the maximum ones – 1.75E-03 (the 1st zone). The contribution percentage of the media under study in the inhalation route of the chemicals' entry was distributed in the following way: the atmospheric air ranked first (91.98%), water ranked second (6.96%), and soil ranked third (1.06%). Thus, it can be said that the highest contribution to the inhalation route of the chemicals' entry is made by atmospheric air (91.98%). Water occupies an intermediate position mainly due to lead and chloroform intake in all zones, in the 2nd zone (2.37E-05 and 1.33E-05 correspondingly), and cadmium in the 1st zone (7.91E-05) in particular. And the lowest contribution is made by soil (1.06%), mainly as a result of arsenic intake in all zones, in the 2nd and the 3rd zones (9.67E-06 and 1.16E-05 correspondingly) in particular.

Carcinogenic risk from exposure to the atmospheric air in the zones under study was distributed in such a way that its minimum values were at the level of 4.28E-04 (the 4th zone), and the maximum ones – 1.62E-03 (the 1st zone). Carbon (soot) in all zones and benzo(a)pyrene in the 4th zone (3.64E-05) occupy the leading position in its formation. The adolescents living in the 1st city zone (1.75E-03), where the individual risk of developing cancer was the highest, were exposed to the highest risk from inhalation exposure to substances.

Discussion of Results

Total carcinogenic risk with the account of peroral exposure (foods, drinking water and soil) ranged from 4.78E-03 (the 4th zonea) to 5.72E-03 (the 1st zone). The contribution of the media under study to the peroral route of chemicals' entry was distributed in the following way: foods ranked first (82.92%), the drinking water ranked second (14.95%), and soil ranked third (2.12%). Thus, it can be said that the major contribution to the peroral route of chemicals' entry is made by foods (82.92%). And soil makes the lowest contribution (2.12%), mainly as a result of arsenic intake in all zones, in the 2nd and the 3rd zones (9.67E-05 and 1.16E-04 correspondingly) in particular.

Carcinogenic risk from drinking water exposure in the zones under study was distributed in such a way that its minimum values were at the level of 1.88E-04 (the 4th zone), and the maximum ones – 1.12E-03 (the 1st zone). The intake of lead and chloroform played a major role in its formation in all zones, in the 2nd zone (2.37E-04 and 1.33E-04 correspondingly) and that of cadmium in the 1st zone (7.91E-04) in particular. The percentage of carcinogenic risk due to intake with foods (82.92%) was determined mainly as a result of lead contamination in adolescents (3.03E-03). The highest total carcinogenic risk from chemicals' intake via peroral route of entry was observed in the 1st (5.72E-03) and the 2nd (5.66E-03) city zones, where the individual risk of developing cancer was the highest.

Total carcinogenic risk with the account of dermal exposure (water and soil) was distributed in such a way that its minimum values were at the level of 1.06E-04 (the 4th zone), and the maximum ones – 1.37E-04 (the 1st zone). The contribution of the media under study to the dermal route of chemicals' entry was distributed in such a way that soil made the major contribution (92.2%), and water – the lowest one (7.8%), mainly as a result of lead and chloroform entry in all zones, in the 2nd zone (2.12E-06 and 1.74E-06 correspondingly), and cadmium in the 1st zone (1.31E-05) in particular.

Carcinogenic risk from the soil exposure in the zones under study varied from 1.04E-04 (the 4th zone) to 1.24E-04 (the 1st zone). The intake of arsenic played a major role in its formation in all zones, in the 1st and the 2nd zones in particular (1.16E-04 and 9.67E-05 correspondingly). The highest total carcinogenic risk from entry of chemicals via dermal route (1.37E-04) was observed in the 1st city zone, where the individual risk of developing cancer was the highest.

The major contribution to the value of total carcinogenic risk on complex exposure of adolescents in all zones under study in the city of Kazan taken into account of chemicals was due to peroral and inhalation routes of their entry – 80.78% and 17.36%, the contribution of dermal route was 1.86%. On peroral route of contaminant entry, its greatest contribution was registered in descending order: 21.34% and 21.13% in the 1st and the 2nd zones, 20.47% in the 3rd zone, and 17.84% inthe 4th zone. On inhalation route of entry, it was 6.52% in the 1st zone, 4.83% and 4.30% in the 2nd and the 3rd zones, and 1.71% in the 4th zone.

It was found out in the course of analysis of the environmental compartment data that impurities of carcinogen-hazardous compounds were present in the atmospheric air, soil, water and foods of certain zones against the background of wide spectrum of chemicals.

Complex assessment of carcinogenic risk in case of multimedium routes of the chemicals' entry showed that there was a risk of developing carcinogenic effects for the adolescents' health on daily intake of contaminants, which made THCR=0.01632.

Conclusions

The value of total carcinogenic risk on peroral, inhalation and dermal routes of entry for the adolescent population in all zones under study corresponded to high risk level, the highest values being observed in the 1st zone (the Kirovsky district), and the lowest ones in the 4th zone (the Privolzhsky district). The priority routes of carcinogen entry into the human body were peroral and inhalation routes. Foods and drinking water, as well as atmospheric air were revealed to be the leading substance transport media in forming individual carcinogenic risk. The major carcinogens forming risk were lead (1.36E-04), chloroform (1.20E-04) and cadmium (7.09E-04) entering with water and arsenic (8.38E-05) – with soil. The leading position among atmospheric air carcinogens in all city zones under study belonged to soot (5.51E-04). The priority pollutant present in foods and defining carcinogenic health risk was lead (2.02E-03).

Acknowledgments

The work is performed according to the Russian Government Program of Competitive Growth of Kazan Federal University.

References

1. Mamyrbaev A. A., Sakebaeva L. D., Sabyrakhmetova V. M., Karashova G. I., Shayakhmetova K. N., Umarova G. A. Risk assessment of non-cancerogenic effects of air pollution in residential areas of the city of Uralsk // Medical journal of Western Kazakhstan, No. 1 (49). 2016, Pp. 82-86.
2. Dolgushina N.A., Kuvshinova I.A. Assessment of air pollution in industrial cities of the Chelyabinsk region and non-carcinogenic risks to public health // Human Ecology, No. 6. 2019, Pp. 17-22.
3. Myakisheva Yu.V., Svetlova G.N., Skazkina O.Ya., Fedoseykina I.V., Bogdanova R.A., Dudina A.I. The incidence of the population as one of the integral indicators of the technogenic load // Sciences of Europe, No. 12. 2017, Pp. 82-85.
4. Ivanenko A.V., Sudakova E.V., Skvortsov S.A., Bestuzheva E.V. Risk assessment of public health from exposure to atmospheric pollution in certain areas of the city of Moscow // Hygiene and sanitation, No. 96. 2017, Pp. 206-211.
5. Valeeva E.R., Ismagilova C.A., Ziyatdinova A.I., Elagina D.S. and Arkhipova N.S. Inhalative Impact of Chemical Pollutants of Atmosphere on the Organism of Teenagers and Risks for their Health //Journal of International Pharmaceutical Research, No. 46(4).2019, Pp. 529-534.
6. Valeeva E.R., Elbahnasawy A.S.M., Ziyatdinova A.I. Evaluation of Chemical safety of Food Products // IOP Conf. Series: Earth and Environmental Science. 2019. No.272-022186. Pp.1-8.
7. ATSDR (Agency for Toxic Substances and Disease Registry) - toxicological profile for cadmium. https://www.atsdr.cdc.gov/ToxProfiles/TP.asp?id=48&tid=15
8. NRC (National Research Council) National Research Council's Human Biomonitoring for Environmental Chemicals National Academy of Sciences, Washington, DC (2012).https://www.canada.ca/en/health-canada/services/environmental-workplace-health/environmental-contaminants/human-biomonitoring-environmental-chemicals.html
9. NRC (National Research Council). National Research Council's Human Biomonitoring for Environmental Chemicals National Academy of Sciences, Washington, DC (2006).https://www.nap.edu/read/11700/chapter/3
10. Cañas A.I., Cañas M., Cervantes Amat M., Esteban M., Ruiz-Moraga B., Pérez-Gómez J., Mayor A. Castaño Blood lead levels in a representative sample of the Spanish adult population: the BIOAMBIENT.ES project // Int. J. Hyg. Environ. Health. 2014. Pp. 452-459.
11. Chaumont A., Voisin C., Deumer G., Haufroid V., Annesi-Maesano I., Roels H. Associations of urinary cadmium with age and urinary proteins: Further evidence of physiological variations unrelated to metal accumulation and toxicity // Environ Health Perspect. 2013. No.121(9). Pp. 1047–1053.
12. Schulz C., Angerer J., Ewers U, Heudorf U, Wilhelm M. Human Biomonitoring Commission of the German Federal Environment

Agency Revised and new reference values for environmental pollutants in urine or blood of children in Germany derived from the German environmental survey on children 2003–2006 (GerES IV// Int. J. Hyg. Environ. Health. 2009. No.212. Pp 637-647.

13. Guidelines for assessing the risk to public health when exposed to chemicals polluting the environment (R 2.1.10.1920-04). - M.: Federal Center for Sanitary Inspection of the Ministry of Health of Russia, 2004, 143p.

Indices y Bases de Datos:
OPEN JOURNAL SYSTEMS
REDALYC (Red de Revistas Científicas de América Latina, el Caribe, España y Portugal)
SCOPUS de Excerpta Medica
GOOGLE SCHOLAR
Scielo
BIREME (Centro Latinoamericano y del Caribe de Información en Ciencias de la Salud)
LATINDEX (Sistema Regional de Información en Línea para Revistas Científicas de América Latina, el Caribe, España y Portugal)
Índice de Revistas Latinoamericanas en Ciencias (Universidad Nacional Autónoma de México)
LIVECS (Literatura Venezolana de Ciencias de la Salud)
LILACS (Literatura Latinoamericana y del Caribe en Ciencias de la Salud)
PERIÓDICA (Índices de Revistas Latinoamericanas en Ciencias)
REVENCYT (Índice y Biblioteca Electrónica de Revistas Venezolanas de Ciencias y Tecnología)
SABER - UCV
EBSCO Publishing
PROQUEST